60

2015 ASBC Annual Meeting

Selective Adsorption of Hop Derived Aroma Compounds by Nonviable Dry Brewing Yeast

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2015 ASBC Annual Meeting
June 14–17, 2015
La Quinta Resort and Club
La Quinta, CA

Abstract

There have been many studies on selective adsorption of nonpolar compounds by viable brewing yeast. Besides the viable brewing yeast, we have found that nonviable dry brewing yeast also has the same characteristic.

1. Introduction

Viable brewing yeast adsorbs nonpolar compounds selectively. Therefore, hop derived nonpolar compounds such as Myrcene and Humulene, resin-like aroma compounds, are adsorbed to a greater extent compared to polar compounds, such as Linalool and Geraniol, floral and/or fruity aroma compounds. This is one of the reasons for favorable modification of hop aroma during beer fermentation.

With this selectivity of viable brewing yeast, hop flavors have been developed by bringing viable brewing yeast into contact with hop oil.

However, the method requires control of fermentation. Furthermore, alcohol is produced and as a result, it could not be used for non-alcohol beverage products, such as alcohol-free beers.

Therefore, the objective of the study was to find a suitable, easy to handle and non-alcohol producing adsorbent which substitutes viable brewing yeast.

2. Materials and methods

(1) Hop oil contact with adsorbents

Activated carbon and synthesized adsorbent, general adsorbents for nonpolar substances, were examined. In addition, nonviable dry yeast, a byproduct of beer produced by drying brewing yeast at 100 degree Celsius more, was investigated since nonviable yeast was reported as a biosorbent for some components[1].

Each adsorbent was contacted with hop oil under stir condition at 12 degree Celsius for 12 hours. Then compared hop aroma compounds before and after the contact.

- Sample (a) : Hop oil + Viable brewing yeast
- Sample (b) : Hop oil + Activated carbon
- Sample (c) : Hop oil + Synthesized adsorbent
- Sample (d) : Hop oil + Nonviable dry brewing yeast

(2) Cell wall breakdown treatment with β-1,3-glucanase

Activated or deactivated (water-bath treatment at 65 degree Celsius for 1 hour) β-1,3-glucanase was added to viable brewing yeast at room temperature for 2 hours before contacting hop oil under stir condition at 12 degree Celsius for 12 hours. Then compared hop aroma compounds before and after the contact.

- Sample (e) : Hop oil + Viable brewing yeast
- Sample (f) : Hop oil + Viable brewing yeast + β glucanase (deactivated)
- Sample (g) : Hop oil + Viable brewing yeast + β glucanase(activated)

3. Results and Discussion

Activated carbon and synthesized adsorbent showed no selectivity in adsorption (Fig. 1b, c).

Nonviable dry brewing yeast, on the other hand, showed a similar selectivity as viable brewing yeast (Fig. 1d).

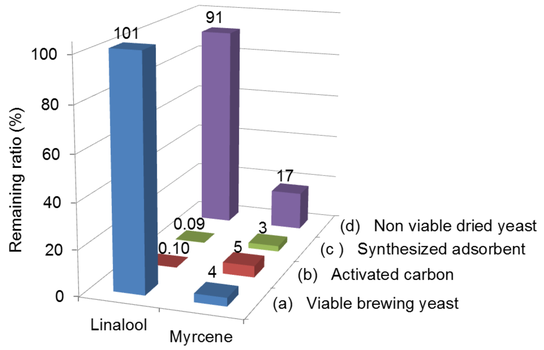

Fig. 1 Remaining ratio* of hop derived terpenoids

*Remaining ratio(%) = (after contact(ppb))/(before contact(ppb)) × 100

Selectivity of nonviable dry brewing yeast has relation with the polarity of the aroma compounds (Fig. 2, Table 1), i.e., compounds that are more polar are less adsorbed.

Nonpolar compounds were detected from rinsing solvent of the nonviable dry brewing yeast after contacting hop oil. Therefore, selective adsorption has probably taken place at the surface of the cells.

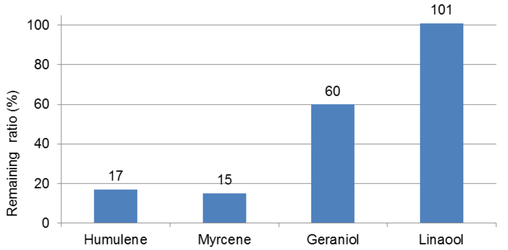

Fig. 2 Remaining ratio* of hop derived terpenoids by nonviable dry brewing yeast

Table 1 Chemical formula, solubility in water, and flavor characteristics of hop aroma substances

Compound	Humulene	Myrcene	Geraniol	Linaool
Compositional formula	$C_{15}H_{24}$	$C_{10}H_{16}$	$C_{10}H_{18}O$	$C_{10}H_{18}O$
Structural formula				
Solubility in water (mg/L at 25 ℃)	0.014	5.6	100	1600
flavor	resinous, earthy, spicy	resinous, woody,leafy	floral, fruity	floral, fruity

Source: The Good Scents Company Information System

Adsorption and its selectivity of viable yeast decreased by cell wall breakdown treatment with β-1,3-glucanase (Fig. 3). Therefore, it is likely that the selective adsorption of aroma compounds by viable brewing yeast takes place at yeast cell wall.

Since the enzyme activates only to viable yeast, the same treatment could not apply to nonviable brewing yeast. However, it is inferred that selective adsorption of nonviable dry yeast also takes place at cell wall.

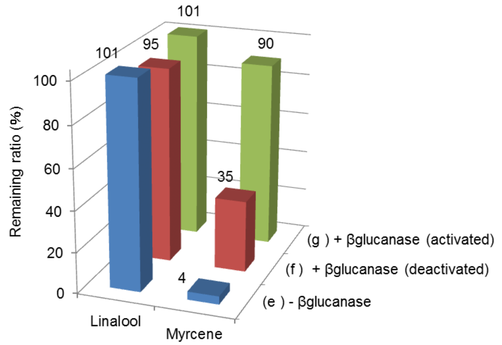

Fig. 3 Remaining ratio* of hop derived terpenoids by viable brewing yeast with and without cell wall breakdown treatment

5. Conclusion

Nonviable dry brewing yeast has revealed as a suitable biosorbent for selective adsorption of hop derived aroma compounds.

Alcohol-free hop flavors produced by the biosorbent could apply to non alcohol beverages such as alcohol-free beers. The adsorbent might also be practical in identifying flavor components in beer.

Reference

1. Tsuji et al., 2013, Intracellular proteins of ethanol-treated yeast cells involved in iron sorption, Food Chemistry, Vol. 141, Issue 3, Pg. 2314–2320